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The role of energy systems' planning in meeting the climate targets: the case of Indonesia, Thailand and Vietnam

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ABSTRACT

This paper investigates the consequences of divergence in policy assumptions in energy planning for preparing national low-carbon pathways and enhancement of Nationally Determined Contributions (NDCs) in Indonesia, Thailand and Vietnam. We present an assessment of the resulting forecasts based on a multimethod exploratory study. Our analysis contributes to an ongoing debate on the policy coherence and integration in the energy sector and climate action strategies. Our results indicate how data availability, ownership and transparency, as well as institutional factors inbuilt in national energy planning impact policy implementation and climate action. This analysis can provide valuable insights for policy-makers working with enhancing NDCs to ensure the updated NDC is actionable.

Keywords: energy systems planning, NDCs, policy coherence

1. INTRODUCTION

The Paris Agreement (PA) adopted by 189 parties to the UNFCCC in 2015 provides a universal, legally binding global framework for action to achieve a long-term goal of limiting the increase in global average temperature to well below 2°C above pre-industrial levels. The PA (Article 4) [1] requires parties to prepare and communicate nationally determined contributions (NDCs) that outline post-2020 climate actions and reflect ambitions to reduce GHG emissions. Parties must update their NDCs progressively every five years to raise the level of ambition over time to comply with the Article 6 of the PA [1].

In recent years, most parties have included measures to accelerate renewable energy deployment and energy efficiency advancements in their national development strategies to prompt transformation towards low-carbon energy systems and to meet the PA goals. Energy planning is key for a timely transformation towards renewable and low-carbon energy systems. Yet, collectively the impacts of the existing policies mix are to be evaluated in more detail.

The way national planning is organized impacts assumptions behind forecasting development of the energy sector and the adoption of GHG emissions reduction targets. National planning in the energy sector involves multiple governmental agencies, institutional levels and multiple steps, starting with gathering data, developing macro-economic models, and analyzing scenarios. It also includes setting broad policy priorities and targets. In some cases, different goals related to the energy sector appear in multiple planning documents. As a result of a lack of policy coherence and occasionally conflicting policy objectives, the implementation of climate actions stated in the NDCs might be compromised. The assumptions behind the type, sources, the choice and the quality of data used to produce the commitments declared in the NDCs are not always explicit. Furthermore, NDC presents aggregated outlooks for different economic sectors (e.g., energy, transport, industry, and agriculture). Consequently, strengthening capacity development around data management and modelling tools is among the most

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commonly reported measures needed to support countries efforts in the revision process and predicting outcomes of their NDCs [2].

The objective of this work is to examine the emission reductions commitment of the current NDCs and the national energy planning projections. The study assesses how the energy systems planning and the national targets related to the energy sector, impact the decarbonization commitments under the PA. Here, using the case of three countries in South East Asia (SEA), namely Indonesia, Thailand, and Vietnam. The analysis is focused on the projected energy mix in the national energy policy frameworks and the forecasted national GHG emissions in 2030.

We contribute to an ongoing debate on the coherence of the goal-oriented energy and climate policy and the role of data quality, availability, ownership and transparency, as well as institutional factors that impact policy implementation and climate action. We aim to provide recommendations for coordination between energy systems planning and preparation of NDC. The analysis provides useful insights into the ongoing process of reviewing and updating the NDCs.

The paper is structured as follows. Following the Introduction, the methods are presented in Section 2. The national circumstances in the case study countries are discussed before the findings and conclusions are presented in section 3. Finally, section 4 highlights the implications for the energy sector and climate change mitigations strategies and suggests the direction for future research.

2. METHOD

This paper is based on a mixed-methods approach, using both qualitative and quantitative methodologies. This multimethod exploratory study employs a multiple case study design and uses three individual case studies - national energy systems planning and NDCs in Indonesia, Thailand and Vietnam. A case-study approach is useful in generating hypothesis that can be tested systematically with a larger set of cases and allows to identify variables for quantitative and structural investigation when studying a particular phenomenon in depth [3] as the 'force of example' [4] [5]. The countries selected are relevant for at least three reasons. First, the countries are the three largest GHG emitters in the SEA region [2]. Second, SEA is a diverse and dynamic region that is an important driver of global economic growth. Third, contemporaneously, policy makers across the region have intensified efforts to ensure a secure, affordable and more sustainable pathway for their energy sectors. This includes increasing investment in energy supply and infrastructure, while focusing on improving sectorial efficiency. These potential benefits of a well-governed expansion of the region's energy system, such as improved access to modern energy, welfare and quality of life for its citizens along with contributions to global efforts to avert climate crisis are significant. The method used for estimating primary energy demand and GHG accounting assesses the impact mitigation measures have on national GHG emissions from the energy sector. The GHG accounting follows the IPCC guidelines [6] and is presented in the sub-sections 2.2 and 2.3. Sub-section 2.1 presents selected input data to build the future energy matrix. The estimated GHG emissions are then compared with the emissions of the energy sector occurred in the different scenarios presented in the NDC.

2.1 Data sources

We collected secondary data through a systematic literature review. We systemized and analyzed publicly available official regulatory and planning documents to compile data and parameters required for further policy analysis. The national energy planning documents included in the analysis are *Rencana Umum Energi Nasional*-the national energy planning (RUEN) for Indonesia [7], Thailand Integrated Energy Blueprint (TEIB) for Thailand [8], and National Energy Development Strategy (NEDS) [9] and Renewable Energy Development Strategy (RES) for Vietnam [10] and their respective Power Development Plan (PDP)[1]. The national energy planning documents provide an overview of the country's energy consumption by sector and the PDP provides details on the electricity sector. The RUEN provides projections of the future energy mix in Indonesia until 2050. For Thailand and Vietnam, the energy system projections were obtained from the 5th ASEAN Energy Outlook (AEO) [11] to complement the official planning document. One of the targets' scenario in the AEO represents recent national energy efficiency and renewable energy targets as specified in Thailand TIEB and Vietnam NEDS and RES that are suitable for the comparison with respective NDCs.

[1] Indonesian PDP [14] Thailand's PDP [28] Vietnam's PDP [29]

2.2 Estimating primary energy demand

The country's primary energy demand (PED) until 2030 was estimated based on the final energy consumption (FEC) of electricity and other energy used in various economic sectors, namely agriculture, commercial, residential, transport and industry. 2015 was taken as a baseline.

$$PED_i(Mtoe) = \sum_i (FEC_i + ETin_i) * \left(1 + losses_i(\%)\right) \quad [1]$$

PED = Primary energy demand
FEC = final energy consumption
ETin = Energy Input in transformation sector
losses = losses in the transformation sector (e.g. for refinery or gas processing)
i = type of fuel

$$ETin_i = ETout_{el}(MToe) * \frac{ELshare_i(\%)}{\eta_i(\%)} \quad [2]$$

ETout = Energy output transformation sector
ELshare = Electricity share of fuel
η = Average efficiency technology for fuel

$$ETout_{el} = \frac{FEC_{el}\ (MToe)}{1 + grid\ losses\ (\%)} \quad [3]$$

The FEC by country is shown in Fig 1.

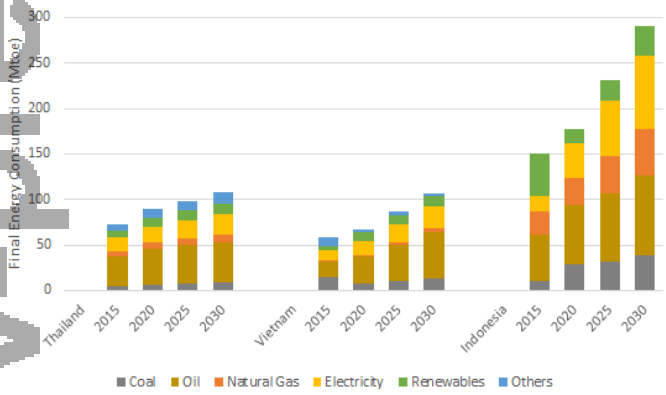

Fig 1 Final Energy Consumption by type of fuel (in Mtoe) [7,11]

2.3 Estimating the GHG emissions

The energy related CO_2 emissions until 2030 are estimated using the default emission factors provided in the IPCC guidelines [6]. Indonesian GHG inventory considers Tier 2 emission factors for CO_2 emissions and Tier 1 for other gases (i.e., CH_4 and N_2O). Whereas Thailand and Vietnam's NDCs applied Tier 1 for activity data in the energy sector. The GHG emissions estimated in this study only include direct emissions CO_2 which is reflected as $MtCO_2eq$.

Table 1. Emission factor in $kgCO_2eq/GJ$

	Coal	Lignite	Oil	Natural gas
Indonesia	100.19	-	75.42	57.65
Thailand	95.53	101.43	74.54	56.15
Vietnam	94.6	-	73.3	56.1

Source: [12,13]

2.4 System boundary and limitations

The present analysis is focused on energy demand and theemissions ($MtCO_2eq$) resulting from energy consumption originating from agriculture, commercial, residential, transport and industry sectors. The analysis' limitations are stemming from the uncertainty of data interpretation.

3. NATIONAL ENERGY PLANNING

3.1 Indonesia

In the past decade, Indonesian energy consumption has been growing at a fast pace driven by a steady GDP and population growth of 5.5% and 1.4% respectively [14]. This growing demand has been satisfied by relying largely on domestic fossil fuel resources, especially coal.

In 2018, 90% of the primary energy supply was composed of fossil fuels dominated by oil for the transport sector and coal for power generation and industry [15]. The recent energy policies aim at ensuring energy security as a mean to develop the domestic economy, optimizing sustainable energy management and ensuring just and equal energy access for all Indonesian [7]. Indonesia's economy-wide NDC targets include a reduction of 29% to Business as Usual (BAU) by 2030, with a conditional clause of up to 38% reduction in GHG emissions. In the energy sector, the target reduction is 19% up to 24% conditional to international cooperation [16].

The main institutions charged with regulation of the energy sector are the Ministry of Energy and Mineral Resources (MEMR), the National Energy Council (DEN), the Ministry of Transportation, and Ministry of National Development Planning of Indonesia (BAPPENAS). In addition to these governmental institutions, the energy sector is strongly influenced by the decisions of the state-owned State Electricity Company (*Perusahaan Listrik Negara*–PLN) that has a de-facto monopoly in electricity distribution and generates most of the country's electricity.

The national energy policy (*Kebijakan Energi Nasional*) in combination with the more recent NDC determines the overarching energy and climate targets for Indonesia. Yet, the coordination among the various

agencies is limited as appears from the cross-analysis of the energy planning documents that often present inconsistent projections. For instance, RUEN-2017 estimates a GDP growth for 2019-2020 of 8% while the 2019 General Plan for Electricity (RUKN) reports a GDP growth of 5.5% for the same period, results in significant divergence in the projections of energy demand growth.

3.2 Thailand

For the past decade, Thailand's total FEC has been steadily increasing from 39.18 Mtoe in 2000 to 75.4 Mtoe in 2020 [17]. The industrial and transport sectors consumed largely three-quarters of the total FEC. The share of energy dependence in 2018 is 65%, more than half of FEC met by imported energy sources. Moreover, energy demand in Thailand is dominated by fossil fuels and expected to increase by 78% by 2036 [8]. The combination of high dependence ratios and today's intensified energy-commodity price volatility could pose a greater energy security challenge in the future.

The key institutions in the energy sector in Thailand that establish the legislative and regulatory framework and design development plans include the National Energy Policy Council (NEPC), the Energy Regulatory Commission, Energy Policy and Planning Office (EPPO), and the Department of Alternative Energy Development and Efficiency (DEDE) [18]. NEPC serves de facto as a coordinating ministry for energy policy making as well as implementation. EPPO provides technical support to the NEPC at the operational level, formulating proposal on national energy policy and strategies. The regulation of the power sector falls under the jurisdiction of the Energy Regulatory Commission. The electricity sector in Thailand from generation to transmission is dominated by the Electricity Generating Authority of Thailand (EGAT).

Recently EPPO has consolidated five preceding individual strategic energy plans into one master plan, Thailand Integrated Energy Blueprint (TIEB 2015-2036). The TIEB combines national energy policy and energy sector development plans and consists of the PDP, the Energy Efficiency Plan, the Alternative Energy Development Plan, the Oil Plan, and the Gas Plan.

The National Economic and Social Development Plan assumes 3.94% of the annual average GDP between 2015 and 2036. Meanwhile, Thailand's NDC aims to reduce GHG emissions by at least 20% from BAU by 2030, with a conditional clause of up to 25% reduction. In the energy sector, the target reduction is 36% up to 50% conditional to international cooperation [19].

3.3 Vietnam

In Vietnam, the demand for energy and reliance on fossil fuels for economic activities and household consumption have been intensifying annually to sustain the ambitious economic growth targets over the past decade. Yet, the government aims to increase the share of renewable energy in the coming years [20]. Vietnam's CO_2 emissions tripled since 1990 [21] and are among the highest worldwide due to a rising share of coal-fired generation [22]. The energy sector is responsible for about half of the GHG emissions. Vietnam is among the most energy-intensive economies globally, largely due to the enduring indirect subsidies to the energy sector through the state owned enterprises.

The power sector falls under the jurisdiction and management of the Ministry of Industry and Trade (MOIT) that coordinates other governmental ministries, agencies and key stakeholders in the process of energy policy formulation and implementation. The Electricity Regulatory Authority of Vietnam (ERAV) regulates the power market, including among others, revising power demand forecasts, performing system studies along with monitoring implementation of power projects [23]. The Electricity and Renewable Energy Authority is currently responsible for energy policy development, including RE, oil, gas, coal and power system planning. The Institute of Energy carries out research on national energy strategies, policies, and development plans and forecasts future demand for energy [23]. The Ministry of Science and Technology (MOST) conducts an appraisal of the draft master plan of energy sector development prepared by the MOIT. Ministry of Planning and Investment (MPI) and the Ministry of Finance (MoF) have planning and fiscal responsibilities in energy planning.

The NEDS and the RES with an outlook to 2050 set principles for energy sector development to ensure energy security and supply, diversify energy investments and energy resources, reduce GHG emissions, scale-up renewables and introduce a competitive energy market. The main energy planning frameworks in Vietnam also include the Green Growth Strategy for 2011–2020 with a vision to 2050 that is complemented by the national Green Growth Action Plan, and the PDP VII revised. The PDP VIII is currently under development and is expected to set more ambitious targets.

The five-year socio-economic development plan for the 2021 – 2025 period set an average annual GDP growth target of 7% [24]. Meanwhile, the Vietnam's NDC targets include a reduction of 8% GHG emissions compared to BAU by 2030, with a conditional clause of

25% reduction. In the energy sector the target reduction is 8% up to 30% conditional to international cooperation [25].

4. RESULTS AND DISCUSSIONS

The Fig 2, Fig 3, and Fig 4 present emission reductions commitment in the energy sector of the current NDC and national energy planning projections of Indonesia, Vietnam and Thailand.

There are inconsistencies between the emissions reduction efforts of the national energy system planning and the NDCs. For Indonesia and Vietnam, the national energy planning sets more ambitious targets than the unconditional and conditional NDC. It implies that Indonesia and Vietnam, following their current energy plans, can reach the conditional NDC targets without international support. Our findings support the conclusions of the Climate action tracker [26] that the national energy planning of Indonesia and Vietnam have more ambitious targets than their NDCs. Indonesia can expect 27% reduction in GHG emissions from BAU based on the RUEN and 45% reduction if the electricity projection incorporates the PDP. Vietnam can meet 34% reduction under NEDS instead of 23% of the conditional NDC target.

For Indonesia, we found that different assumptions for electricity growth in various planning document result in discrepancies in the estimation of emissions reduction targets. In particular, adopting the latest projections presented in the PDP [14] results in an improvement of the emission target by an additional 18% compared to the RUEN scenario. The electricity planning in PDP administered by PLN is not aligned with RUEN that is under the responsibilities of Indonesian MEMR. The inconsistencies between Indonesian RUEN, PDP and NDC may be the results of uncoordinated planning between numerous agencies involved in energy planning. The Indonesian and Vietnam's NDC do not indicate explicitly renewable energy and energy efficiency targets, making it difficult to verify the climate mitigation actions in the energy sector set by the NDCs.

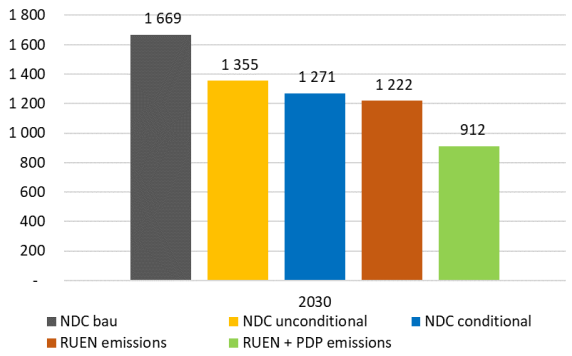

Fig 2. Comparison between emissions reduction target of NDC, RUEN and PDP of Indonesia by 2030, in MtCO2eq

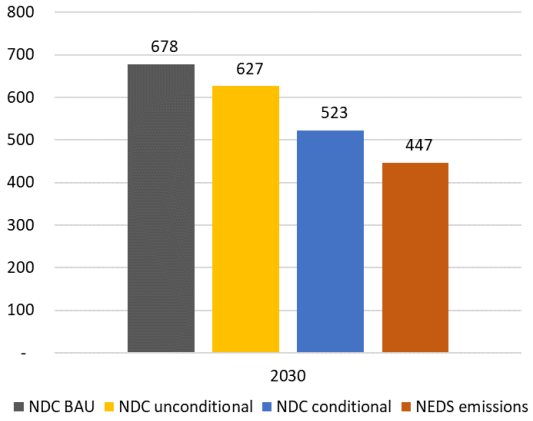

Fig 3. Comparison between emissions reduction target of NDC, NEDS of Vietnam by 2030, in MtCO2eq

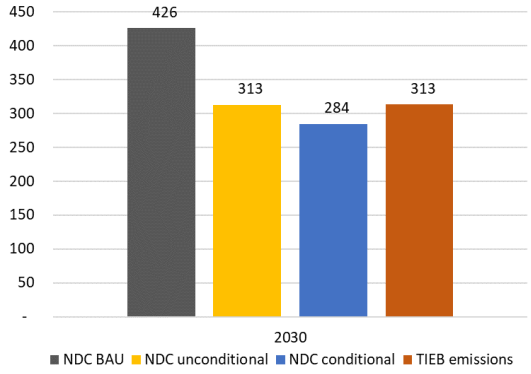

Fig 4. Comparison between emissions reduction target of NDC and TIEB of Thailand by 2030, in MtCO2eq

The analysis carried out for Thailand shows that the emissions level estimated in the unconditional NDC is in accordance with the TIEB set to reach 26% reduction target compared to BAU level by 2030. More mitigation efforts are needed to reach the conditional target. TIEB consolidates the energy plans (oil, gas, power, alternative energy and energy efficiency) with the same timeframe, which allows for more consistent use of the

crucial parameters in the projections of future energy systems. A standardized baseline year in the projection of energy systems across different regulatory framework is also important for streamlining national mitigation and energy sector targets. Finally, consistency in setting timeframes under different policy instruments enables coherence in policy-making [27].

5. CONCLUSIONS AND FUTURE RESEARCH

Our analysis can provide valuable insights for policy-makers working with enhancing NDCs to ensure updated NDCs are also actionable. While the present research verifies the issues in terms of inconsistencies in the various planning documents and policy instruments, it has methodological limitations and can benefit from furthering the quantitative approach. The application of a modelling tool of Low Emissions Analysis Platform (LEAP) will lead to a more systematic analysis and robust results. This approach will improve the projections of the future development of the whole energy system, including the final energy demand by sectors and fuels, energy consumption in the transformation sector (e.g. power sector and refinery sector), the primary energy requirements, primary production of fossil fuels and reserves, as well as the CO_2 emissions.

As the next step, we will further investigate the updated energy systems planning, for example in Thailand's TIEB (2018-2037) and Vietnams' forthcoming PDP VIII to estimate their impact on the implementation of NDCs. Finally, the future research will focus on the variety of energy planning approaches (centralized, decentralized, integrated, strategic or community energy planning) and institutional factors associated with uptake of knowledge in national energy planning.

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